Space Weather Technical Forecast

Issued on Thursday, 22 September 2022 at 13:09 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1-R2 Radio Blackouts throughout. G1 Geomagnetic Storm intervals Likely 23 September, Chance G2. Likely Active Electron Fluence following over UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity fell to Low over the past 24 hours, with frequent small C-class flares observed at GOES16 and 17, interspersed by isolated more noteworthy flares. The peak of these larger events was a C7.8 observed from AR3105 at 22/1134UTC. There were up to five sunspot regions on the disc in the period, with a sixth fading early on (AR3106) in the southeastern quadrant. The largest sunspot group on the disc was the aforementioned AR3105, which appeared as a Dkc/Beta. This group showed minor growth in its intermediate and leading spot groups, with a slight overall areal increase also seen. To its immediate east was AR3107, which is thought likely to be hiding detail given its proximity to the eastern limb, but currently appears as a Cki/Beta-Gamma. This group showed only minor reconfiguration in its small southern spots. Nearer the meridian, a rapidly-developing group was numbered AR3109 in the 24 hours, although thus far having only attained Bxi/Beta classification having recently been plage. More modest growth was seen to its south in AR3108, which became a Cro/Beta. Finally, AR3102 showed gradual decay in the southwestern quadrant as a Dso/Beta.

Coronagraph imagery in the period showed a slow CME as heading mainly south and east of the Sun-Earth line from around 21/1630UTC (in C2), the source of which is speculative, but is perhaps best correlated with one of the southeastern quadrant groups of AR3105 and 3107. A tentative analysis of this eruption has been conducted, with the result that a glancing blow is perhaps possible later on Sunday 25 September. It should be noted that no triangulating imagery was available from STEREO A for this analysis, and further refinement will be carried out if and when this materialises.

Immediately prior to the issuing of this guidance, a faint partial halo signature began to appear on Lasco C2 imagery between 12 and 04 o'clock on the disc. The source for this is unclear (perhaps even being far-sided). Possible front-side sources are few, but there was a very faint dimming associated with the rapid emergence of AR3109 centre-disc at 22/0130UTC, however this attribution is far from certain. Analysis will be conducted in due course.

Also observed in the 24 hours was a filament eruption from near the northeastern limb around 22/0200UTC. This is thought to now be appearing heading behind and slightly above the Earth in the track of its orbit to no anticipated effect at Earth.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, has shown a continuing gradual resumption of a slow regime. The solar wind speed fell from an early high near 510km/s to reach 400 by the period's end. The solar wind density mostly showed a decline within its typical range of single figures ppcc, but there was a small uptick to slightly elevated levels near 10ppcc at the end of the 24 hours. The IMF was small scale and stable, with a peak of 6nT and a north-south component generally co-aligned with Earth's field and

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ranging between +5 and -2nT. The phi angle was mostly negative (towards the Sun), but with brief spells in positive orientation, notably around 04UTC and from 08UTC, the latter perhaps suggestive of an SSBC.

The net result of the above solar wind measures was for mostly Quiet geomagnetic activity, provisionally at or below Kp1 throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, continued its roughly week-long downward trend to be close to Background levels.

High energy electron flux (greater than 2 MeV) was at Normal Background to Moderate levels, with peak value 384 pfu at 20/1410UTC. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold. Observed fluence at 22/0001UTC was 1.32e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate with further C-class flares Expected and a with an ongoing Chance of M-class flares. The main flare risk remains from AR3105 and AR3107 in the southeastern disc.

Solar Wind / Geomagnetic Activity: There is tentatively a risk of a glancing blow later in the UTC day of Sunday 25 September from a CME seen leaving the southeastern disc late on 21 September. This feature will be further analysed should imagery become available.

Otherwise, Slightly Elevated solar winds will gradually ease towards background over the remainder of day one (Thursday 22 September). The next enhancement from the fast wind of CH25/+ is then expected day two (Friday 23).

Generally Quiet geomagnetic activity is therefore expected until early day two. Activity should then increase to Active to G1/Minor Storms, with a Chance for G2/Moderate Storm intervals. Conditions should then provisionally ease to Quiet to Unsettled by day four, Sunday 25 September, although there is now a tentative Slight Chance of further G1 intervals should the 21 September CME arrive later in this UTC day. This final aspect is particularly low confidence.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES16, is expected to persist at Background levels.

The high energy electron flux (greater than 2 MeV) is expected to be at Background to Moderate levels at first, before rising day three and day four (the UTC weekend days) in response to fast wind arrival from CH25/+.

The associated 24-hour fluence is expected to stay below the Active (1e8 integrated pfu) threshold for much of the period, but likely rising above by the end of day three (24 September). The chances of Active fluence have been attenuated at the very end of the period due to any CME influence.

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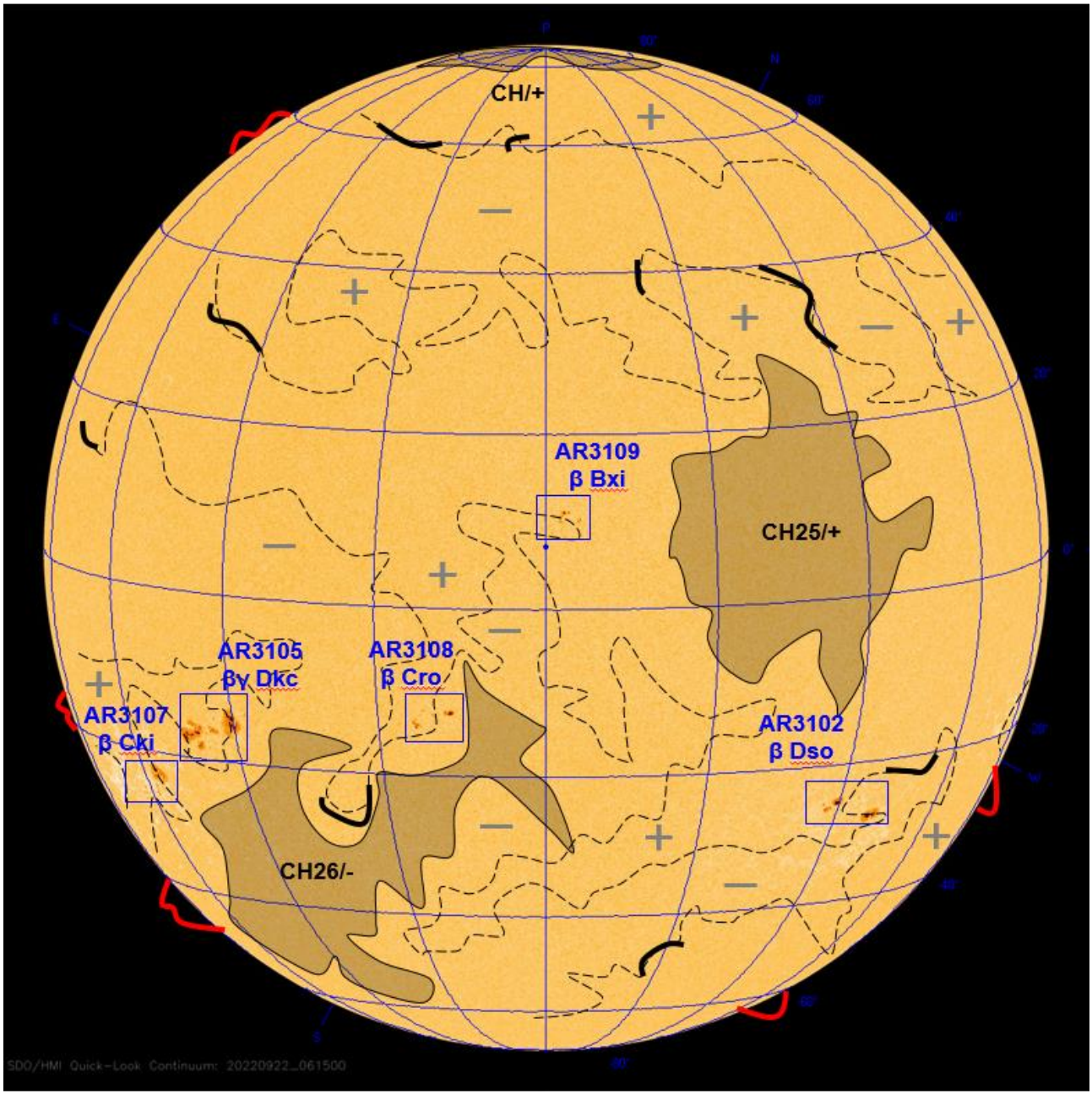
Figure 1. Solar Analysis Valid 21/1815UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A slow CME seen leaving the southeast disc in C2 imagery during the final quarter of the UTC day of 21 September has been provisionally assessed as having a possible Earth-directed component. MOSWOC Enlil suggests that a glancing blow is possible later in the UTC day of Sunday 25 September, which in this case serves to increase the 'tail' of G1 risk from the otherwise expected fast wind of CH25/+. The CME aspect of the forecast is dynamic, and further analysis will be conducted should further triangulating imagery from STEREO A become available.

Solar winds continue to ease from their slightly elevated levels, likely soon declining into background through the remainder of day one (Thursday 22 September). The next enhancement will be from the arrival of the fast winds of CH25/+. This is a much larger and more well-defined feature on this rotation. STEREO A is now showing this expected enhancement as of 21/2000UTC putting synonymous arrival at Earth on Friday 23 September, whereupon 500-600km/s speeds may be expected. This is coincidentally the day of the autumnal equiniox, and by some theories this represents the annual peak in geoeffectivity for features of this type, hence, in part, the risk of G2.

Geomagnetic activity is expected to be generally Quiet day one (Thursday 22 September). Activity should then increase to Likely G1/Minor Storms, with a Chance for G2/Moderate Storm intervals on 23 September. Conditions should then ease for a time, only for a possible late increase on day four, Sunday 25 September should the 21 September CME materialise.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	70	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/0532	Partial	AR3105?	SE quadrant	309km/s	Later UTC day of 25 September	Uncertain source. No STEREO A, Faint on Lasco. Low confidence.

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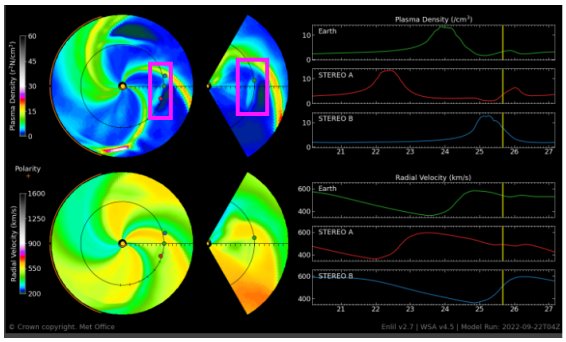
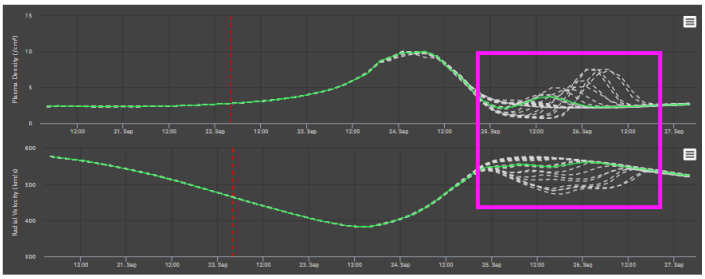
Figure 2: Latest MOSWOC Enlil and ensemble, showing boxed in magenta a possible glancing blow from the 21 September CME. This feature is of uncertain origin, but perhaps best correlates with activity from AR3105. Further analysis will be conducted should imagery become available.





Radio Blackouts - X-Ray Flares:

Solar activity is forecast to be Low to Moderate, with ongoing C-class flares and a Chance of further M-class flares. There are now five numbered sunspot regions on the Earth-facing disc.

Nominally the most complex of these groups is AR3105 in the southeast, which now appears as a Dkc/Beta given recent leading spot growth, although this is not bearing out in observed flares, perhaps because of a relative lack of growth and shear, as well as its relatively plain east-west dipole division. By contrast, the spot to its immediate southeast, AR3107 seems to be producing activity above its class, which is tentatively a Cki/Beta-Gamma, although this is perhaps because detail is not discernible given the viewing angle.

The current crop of sunspots should all see out the four-day forecast period, meaning no changes are anticipated to the flare forecast, however far-side soundings perhaps suggest that this hemisphere is the more active, with at least four strong echoes showing across the disc. The outlook is therefore provisionally for a worsening of flare risk, but the probabilities are held pending any arrivals for analysis.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

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Figure 3: HMIIF and HMIBC imagery of two of the more complex regions on the current disc.

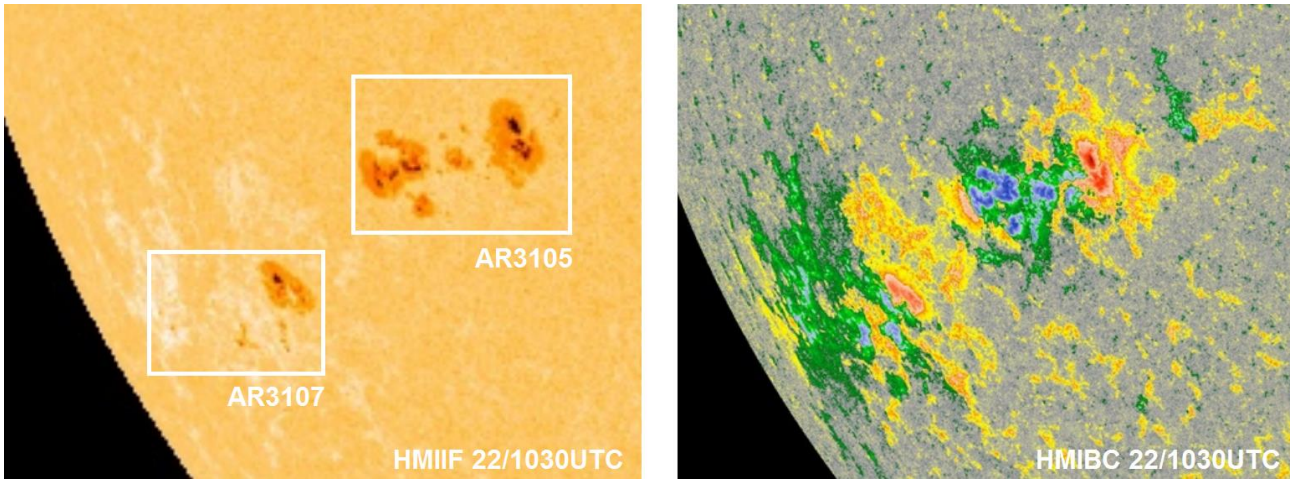
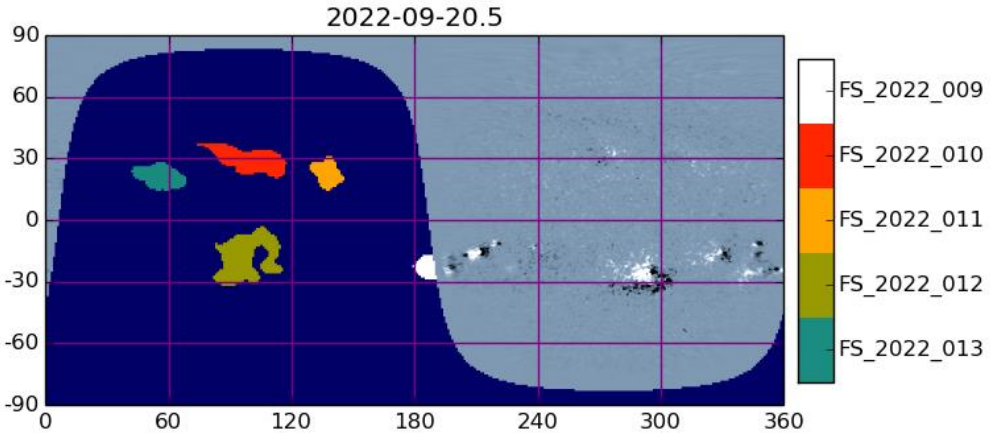


Figure 4: Recent far-side sounding, showing several large potential far side regions - potentially of relevance for the forthcoming week, and a reason to suspect the outlook in terms of activity may be for an increase.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to continue its roughly week-long descent towards low Background levels. The main flare risk sunspots currently populate the southeastern disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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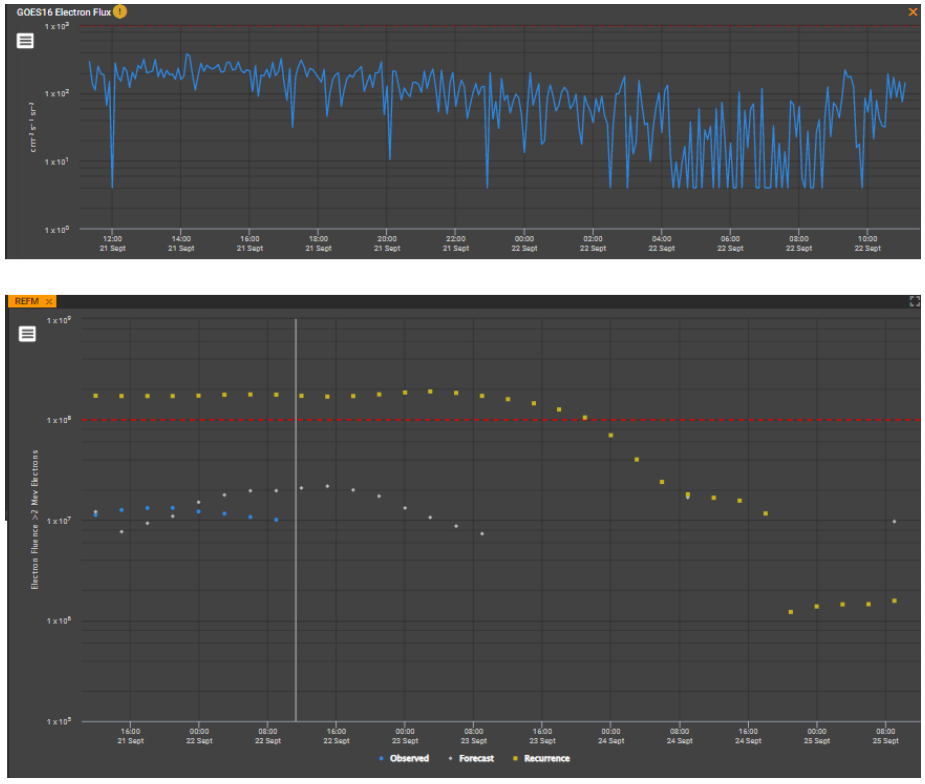
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES16, is currently Background to Moderate. The arrival of the fast wind of CH25/+ later on day two (Friday 23 September) is expected to enhance electron populations at Earth, with High flux levels perhaps developing once any initial geomagnetic activity subsides over the UTC weekend. The chances of this occurring have been mollified slightly given the possible glancing incidence of any 21 September CME and its attendant geomagnetic activity.

The associated 24-hour fluence is expected to remain below the Active (greater than 1e8 integrated pfu) threshold until Saturday 24 September, with REFM giving a good guide to current conditions and trends until at least day two (Friday 23 September). However the expected fast wind arrival is likely to be stronger than persistence suggests, limiting the models performance beyond this date.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	60	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: Past 24 hours in greater than 2MeV high energy electrons (top) and 24-hour fluence (bottom, blue dots). The latest MOSWOC REFM forecast is felt likely to be underdoing the expected response to CH25/+, which should instead react sharply upwards for a time over the UTC weekend.



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